The frontal-zygomatic approach vs. the anterior approach for orbital tumor surgery: a retrospective review of the indications and outcomes

Shinichi Asamura1, Kazuhide Matsunaga2, Kazunori Mori3, Tadaaki Morotomi1, Noritaka Isogai1

1Department of Plastic and Reconstructive Surgery, Kinki University Faculty of Medicine, Osaka, Japan
2Department of Oral and Maxillofacial Surgery, Kagoshima University Graduate School of Medical and Dental Sciences, Kagoshima, Japan
3Department of Otolaryngology-Head and Neck Surgery, Kinki University Faculty of Medicine, Osaka, Japan

Abstract: Purpose: The orbit, a major esthetic constituent of the face, is important in our social lives. Therefore, a careful approach is required for orbital tumor surgery, during both radical treatment and biopsy. To achieve a wider operative field, we developed a frontal-zygomatic (FZ) approach, in which bone of the superior or inferior wall is resected en block. Methods: The subjects consisted of 42 patients for whom a diagnosis of orbital tumor was made by preoperative diagnostic imaging and histopathological examination. Tumor resection was performed in 16 patients and tumor biopsy in 26. Following the adoption of the FZ approach for surgical intervention, we evaluated the postoperative complications and classified them into one of four categories: diplopia, enophthalmos, paralysis, or scar formation. Results: In all patients, a definite diagnosis was made by surgical intervention, showing that tumor resection and biopsy were useful. Conclusions: Because the FZ approach caused no significant postoperative complications and produced excellent results, we believe that this approach should be followed in most cases other than tumors centering on the orbital apex or extending into the optic canal.

Key words: Orbital tumors, Osteotomy, Frontal-Zygomatic approach

Introduction

In surgical approaches to orbital tumors, a two-step surgical procedure consisting of a skin incision in the head/face or an incision in the palpebral conjunctiva and craniofacial osteotomy is necessary. When a surgical technique is selected, it is important to achieve a sufficiently wide operative field for safe and accurate tumor resection and also to minimize secondary facial injuries such as scar formation, deformation, or functional impairment. However, because the two requirements are contradictory, it is not easy to achieve both at the same time. Typically, a transcranial approach via a skin incision in the head is selected by neurosurgeons, while anterior and lateral approaches are favored by ophthalmologists; accordingly, many surgical techniques have been reported (1-3). The transcranial approach frequently requires a wider operative field, and patients tend to suffer from postoperative discomfort and require a longer recovery period (1, 4-5). On the other hand, the lateral approach often does not provide an adequate operative field for successful tumor removal (3, 6-7).

To overcome these operative barriers, various surgical techniques have been devised (8-9). Recently, we have developed a surgical approach, named the frontal-zygomatic (FZ) approach, which addresses the two seemingly contradictory goals of providing both an adequate operative field and acceptable cosmetic repair of the surgical disfigurement to patients. In this study, we evaluate the FZ approach in terms of postoperative complications. In order to determine whether this surgical technique was valuable for those surgical interventions, we have applied this approach to surgery as well as to biopsy of orbital tumors.

Materials and methods

Subjects

The subjects consisted of 42 patients in whom a diagnosis of orbital tumor was made by preoperative
Table 1. Histopathological diagnosis of orbital tumors in 42 patients

<table>
<thead>
<tr>
<th>benign</th>
<th>number of case</th>
</tr>
</thead>
<tbody>
<tr>
<td>inflammatory pseudotumor</td>
<td>10</td>
</tr>
<tr>
<td>pleomorphic adenoma</td>
<td>5</td>
</tr>
<tr>
<td>cavernous hemangioma</td>
<td>5</td>
</tr>
<tr>
<td>epidermoid cyst</td>
<td>2</td>
</tr>
<tr>
<td>schwannoma</td>
<td>2</td>
</tr>
<tr>
<td>others</td>
<td>6</td>
</tr>
<tr>
<td>subtotal</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>malignant</th>
<th>number of case</th>
</tr>
</thead>
<tbody>
<tr>
<td>malignant lymphoma</td>
<td>12</td>
</tr>
<tr>
<td>subtotal</td>
<td>12</td>
</tr>
<tr>
<td>total</td>
<td>42</td>
</tr>
</tbody>
</table>

diagnostic imaging and histopathological examination between January 2004 and December 2009. Patients with secondary tumors as a result of infiltration from adjacent areas such as the eyelid or paranasal sinus were excluded, and only those with primary orbital tumors were included. There were 22 males and 20 females aged 32-78 years (mean, 63 years), and the number of patients aged 60-69 years was the highest (12 patients). A unilateral lesion was observed in 40 patients and bilateral lesions in 2. There were 30 benign tumors and 12 malignant tumors. Histopathological examination showed 10 inflammatory pseudotumors, 5 lacrimal pleomorphic adenomas, 2 epidermoid cysts, 5 hemangiomas, 2 Schwannoma and 6 others benign tumors, and 12 malignant lymphomas (Table 1).

Surgical techniques

In tumor resection or biopsy, we selected an anterior approach for tumors that were located in the anterior area (near the equator of the eyeball) and the FZ approach for tumors posterior to the equator of the eyeball that required osteotomy. One month after the operation, the complication rates were studied in terms of the incidence of diplopia, enophthalmos, and paralysis of the infraorbital nerve.

<Anterior approach> A skin incision was made just below the eyebrow for tumors located in the superior area and just below the eyelashes for tumors located in the inferior area, and the orbital septum was exposed and incised to allow access to the tumor.

<FZ approach> For tumors located in the superior area, a skin incision was made from the lower margin of the central area of the eyebrow to the zygomatic arch in a gently curved S pattern. For tumors located in the inferior area, a skin incision was made horizontally from the lower margin of the eyelashes at the lateral canthus to the aperture of the ear (Fig. 1a). Subsequently, subcutaneous tissue was bluntly dissected, and the periosteum and temporal muscle were exposed. The periosteum was incised about 3 mm posterior to the orbital bone margin along the bone margin using an electric scalpel. From this incision margin, the periosteum on the lateral, superior, and inferior sides of the orbital wall could be readily dissected to the area near the orbital apex using a periosteum elevator.

For tumors in the superior area, the osteotomy line was determined to be lateral to the supraorbital nerve groove superiorly and the level inferior to the frontozygomatic suture inferiorly. For tumors located in the inferior area, the osteotomy line was inferior to the frontozygomatic suture superiorly and lateral to the infraorbital nerve groove inferiorly. With protection using a brain spatula to avoid injuring surrounding tissue, osteotomy was performed using a bone saw, followed by advancement to deep areas using a bone chisel and wood hammer. Finally, fracture was induced at the zygomatic bone-sphenoid bone suture area by holding and mobilizing the bone fragment using bone forceps. This provided a clear operative field, and the tumor could be reached after an orbital periosteal incision (Fig. 1b).

<Tumor identification and excision> The orbit was entered through a T-shaped orbital periosteal incision, and the lateral rectus muscle was identified and used as a reference of the anatomical position. The incision was...
advanced to orbital fat tissue between the lateral and superior rectus muscles for tumors located in the superior area, and between the lateral and inferior rectus muscles for tumors located in the inferior area. When tumor identification was difficult, palpation with the fingertips was important. While abnormal tissue was touched with the fingertips, the surrounding normal tissue was bluntly dissected and the tumor was separated.

<Closure of surgical wounds> After tumor resection, complete hemostasis was confirmed, and the orbital periosteum was closed by simple suturing with 5-0 Vicryl. The bone fragment was returned to its original site, and a hole for fixation was made in the bone. The bone was fixed with 3-0 nylon and enveloped with the periosteum, and simple suturing with 5-0 vicryl was performed. The subcutaneous and skin tissues were closed with 6-0 nylon. A Penrose drain (6 mm in width) was inserted and the operation was completed.

Results

The anterior approach was used in 26 patients and the FZ approach in 16. No postoperative complications such as diplopia or enophthalmos were observed in any patient. Paralysis of the infraorbital nerve was observed in 3 cases with the FZ approach (Table 2).

Patients in whom the tumor was resected by the FZ approach presented as follows.

<Case 1> A 47-year-old male noticed swelling of the left upper eyelid in 2004 but did not seek medical treatment. Subsequently, exophthalmos became marked, and eyelid elevation became difficult. Preoperative MRI showed a well-delineated caterpillar-like tumor in the left orbit. The tumor compressed the superior rectus muscle downward, extending to the superior orbital fissure (Fig. 2a). In July 2008, the tumor was resected by a FZ approach from the superior area. A skin incision was made from the lower margin of the central area of the eyebrow to the zygomatic arch in a gently curved S pattern. The osteotomy line was determined to be lateral to the supraorbital nerve groove superiorly and the level inferior to the frontozygomatic suture inferiorly. The orbital perioveal incision was advanced to orbital fat tissue between the lateral and superior rectus muscles for tumor resection. Histopathological examination demonstrated Schwannoma (Fig. 3). Postoperative MRI showed no recurrence (Fig. 2b).

<Case 2> A 53-year-old male noted “seeing stars” in 2002 but did not seek medical treatment. Orbital pain was aggravated. Preoperative T2-weighted MRI images showed a high-intensity tumor with smooth margins in the left orbit (Fig. 4a). In July 2007, the tumor was completely resected by a FZ approach from the inferior area. A skin incision was made horizontally from the lower margin of the eyelashes at the lateral canthus to the aperture of the ear. The osteotomy line was inferior to the frontozygomatic suture superiorly and lateral to the infraorbital nerve groove inferiorly. The orbital perioveal incision was advanced to orbital fat tissue between the lateral and inferior rectus muscles for tumor resection. Histopathological examination demonstrated cavernous hemangioma (Fig. 5). Postoperative CT showed no recurrence, and it showed the preserved morphology of the orbital bone after osteotomy (Fig. 4b).

Table 2. Summary of postoperative complications of intraorbital tumors by surgical approaches

<table>
<thead>
<tr>
<th>surgical approach</th>
<th>biopsy/excision</th>
<th>postoperative complications</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>diplopia</td>
</tr>
<tr>
<td>anterior (U*)</td>
<td>10/5</td>
<td>0/0</td>
</tr>
<tr>
<td>anterior (L)</td>
<td>7/3</td>
<td>0/0</td>
</tr>
<tr>
<td>fronto-zygomatic (U)</td>
<td>5/4</td>
<td>0/0</td>
</tr>
<tr>
<td>fronto-zygomatic (L)</td>
<td>4/4</td>
<td>0/0</td>
</tr>
<tr>
<td>total</td>
<td>26/16</td>
<td>0/0</td>
</tr>
</tbody>
</table>

*U, upper; §L, lower
Discussion

Orbital tumors can be clinically diagnosed very accurately based on the present illness and findings of neuroradiological examinations. However, despite advances in diagnostic imaging techniques such as CT and MRI, a definite diagnosis cannot be made, and the treatment method cannot be selected without histological diagnosis. In orbital diseases including non-specific orbital inflammatory syndrome (orbital pseudotumor), a clinical diagnosis cannot be made without surgical intervention. Surgery in the orbital area is indispensable for diagnosis and treatment. Therefore, the importance of surgical approaches to orbital tumors can be classified as either (i) tumor resection aiming at the radical treatment of the tumor or (ii) tumor biopsy for a definite histopathological diagnosis between diagnostic imaging and noninvasive treatment. In this study, tumor biopsy provided a definite diagnosis of malignant lymphoma in 12 cases. With the continued growth of the aging population, cases of malignant lymphoma are expected to further increase, and surgical intervention for definite diagnosis will become more important in the future.

Surgical approaches to orbital tumors are classified as one of three types: anterior, lateral, or transcranial (6-9). An appropriate approach is selected based on the location of the tumor. For large tumors and those located deep in the orbit, the transcranial approach has been used. However, surgical manipulation through this approach involves not only the orbit but also the cranial bone, requiring the cooperation of neurosurgeons. Thus, the surgical procedure is difficult and complicated. This approach provides a wide operative field, but surgical invasion is marked due to craniotomy. Direct invasion to the levator and superior rectus muscles or invasion to the superior orbital fissure is often necessary, which increases the risks of postoperative complications such as a decrease in the visual acuity or oculomotor impairment (10). We have encountered patients who developed such complications.

Therefore, we developed the present surgical approach to satisfy these goals, namely (i) to minimize the operative field, and (ii) to provide acceptable cosmetic repair of the surgical disfigurement to patients. The anterior approach is selected for shallow tumors near the equator of the eyeball. Tumors located in the superior area are approached through an anterior approach in a gently curved S pattern. A skin incision was made from the lower margin of the central area of the eyebrow to the zygomatic arch in a gently curved S pattern. A skin incision was made horizontally from the lower margin of the eyelashes at the lateral canthus to the aperture of the ear (a). An osteotomy line was determined to be lateral to the supraorbital nerve groove superiorly and the level inferior to the frontozygomatic suture inferiorly (b). A well-encapsulated tumor was extirpated in a large operative field (c). On the cut surface, the tumor was white, soft and gelatinous (d).
a skin incision just below the eyebrow, which is the same incision as that used in surgery for blepharoptosis (11). Tumors located in the inferior area are approached through a skin incision just below the eyelashes, which is also the same incision as that used in the correction of drooping eyelid (12). Both incisions are used in cosmetic surgery, and produce esthetically excellent results, causing only inconspicuous postoperative scars.

On the other hand, surgical approaches to orbital tumors have been directed toward minimally invasive approaches in recent years. Some studies have shown that a wide operative field can be achieved not only using approaches via a skin incision but also via a conjunctival incision. In a conjunctival incision, the low lid retractor, which is considered to be the main cause of entropion of the eyelid, is cut. Though this low lid retractor is fixed at its original position by suturing of the conjunctiva incised immediately below the tarsus, deformation of the lower eyelid, such as entropion, might occur in the long term. In addition, since lateral canthotomy is performed to achieve a wide operative field, there is a possibility that inadequate reconstruction of the lateral palpebral ligament during wound closure could cause deformation/deviation of the lateral canthus (13). Therefore, approaches via a skin incision may be comparable to those via a conjunctival incision in terms of straightforwardness, achievement of a wide operative field, and the cosmetic aspect (Fig. 6).

Through the anterior approach, the operative field is considered to be inadequate to remove the tumor successfully, thus the FZ approach is suggested for tumors located posterior to the equator of the eyeball. This approach differs from the anterior approach in terms of whether the skin incision extends to the lateral side of the face, and whether osteotomy is necessary. In the conventional lateral approach, the osteotomy line in the bone of the outer wall of the orbit has been discussed, but not the osteotomy line in the frontal and zygomatic bones (14). Therefore, to achieve a wider operative field, we developed the FZ approach in which bone of the superior or inferior wall is resected en block. In superior wall osteotomy, the osteotomy line is 1 cm lateral to the supraorbital nerve groove. This osteotomy results in detachment of the frontal bone at the orbital superior margin with an eave-like shape, which markedly widens the operative field. The involvement of the eave-like portion within 1 cm from the orbital superior margin causes no brain damage.
injury. In inferior wall osteotomy, the osteotomy line is slightly lateral to the infraorbital nerve groove. This osteotomy allows en bloc detachment of the zygomatic bone constituting the orbital inferior wall, which facilitates the exposure of the surgical field. After operation, anesthesia in the infraorbital nerve region was observed in 3 cases. This may be due to contact with the suborbital nerve during en bloc osteotomy of the zygomatic bone. The FZ approach can be performed in most cases other than tumors centering on the orbital apex or extending into the optic canal.

The orbit is narrow and deep. In this narrow tapered space surrounded by bone, important organs and tissues such as the eyeball, optic nerve, extraocular muscles, nerves, and blood vessels complicatedly intertwine with one another, and the apex of this space is continuous with the cranial cavity (15-16). In addition, this space is filled with fatty tissue protecting these organs. In the surgical approach to the orbit, the deep narrow orbit surrounded by bone provides a narrow operative field, and the completion of surgical manipulation with the preservation of normal tissue is important. In this study, there were many cases of tumors that are frequently present in the muscle cone: malignant lymphoma, inflammatory pseudotumor, and cavernous hemangioma (17). The resection of such tumors sometimes causes postoperative complications due to adhesion of the extraocular muscle or nerve. However, no diplopia and blepharoptosis was observed in any patient.

For shallow lesions, the anterior approach seems to be satisfactory, whereas for lesions located in the deep tissue, the FZ approach is preferable at our institution.

References